

35. (NEW) A projection exposure apparatus according to claim 34 wherein the light source comprises an F₂ laser.

36. (NEW) A projection exposure apparatus according to claim 35 wherein the light source comprises:

an oscillator generating radiation having a linewidth narrower than a natural linewidth thereof; and

an amplifier capable of amplifying the output of the radiation generated by the oscillator.

37. (NEW) A projection exposure apparatus according to claim 36 wherein the linewidth of the radiation supplied by the light source is not more than 0.3 pm as measured on a full-width-at-half-maximum basis.

38. (NEW) A projection exposure apparatus according to claim 37 wherein the at least two fluoride substances collectively include two species selected from among the group consisting of calcium fluoride, barium fluoride, lithium fluoride, magnesium fluoride, strontium fluoride, lithium calcium aluminum fluoride, and lithium strontium aluminum fluoride.

REMARKS

Claims 1-30 are pending in this application. Claims 1, 9, 10, 29, and 30 are independent claims. Claims 2-8 and 11-28 are dependent claims.

Claims 1-9 and 29 have been allowed. Claims 10-28 and 30 have been rejected. Amendments to claims 10, 16, 19, 22, 24, 27, and 30 are presented herein. Claim 30 has been amended to improve form, without changing substance. Claims 15 and 23 have been cancelled in this Amendment. Claims 31-38 have been newly added in this response. The Abstract has been amended to improve form. No new matter is being presented, and approval and entry are respectfully requested.

Information Disclosure Statement

In item 1 on page 2 of the Office Action, the Examiner indicated that three references cited in an Information Disclosure Statement filed February 22, 2002 have been reviewed and placed in the file for the present application, but that the references have been crossed out on the PTO-Form 1449 because these references are not published U.S. patents and will not be printed. The three references include application numbers 09/736,420, 09/377,010, and 09/865,734

Application number 09/736,420 was published (publication no. 2001-0012099) on August 9, 2001. Application number 09/377,010 issued September 17, 2002 as patent number 6,451,507. Application number 09/865,734 was published (publication no. 2002-0005938) on January 17, 2002.

Accordingly, it is requested that the Examiner confirm consideration of these references by initialing these references on the PTO-Form 1449 and returning a copy of the initialed form to Applicant. For the Examiner's convenience, a copy of the PTO-Form 1449 is attached to this request.

Objection To The Abstract

In item 2 on page 2 of the Office Action, the Abstract was objected to for the reasons set forth therein. In view of the amendments to the Abstract presented herein, the objection to the Abstract should be resolved.

Rejections Under 35 U.S.C. § 112, Second Paragraph

In items 3 and 4 on pages 2 and 3 of the Office Action, the Examiner rejected claims 10-28 and 30 as being indefinite for the reasons set forth therein. Applicant submits that amendments to the claims presented herein meet the requirements of 35 U.S.C. § 112, second paragraph. Accordingly, Applicant respectfully requests withdrawal of the rejections to claims 10-28 and 30 under § 112, second paragraph.

Rejections Under 35 U.S.C. § 102

In items 5 and 6 on pages 3 and 4 of the Office Action, the Examiner rejected claims 10-12, 21, 24-28, and 30 under 35 U.S.C. § 102(e) as being anticipated by Suenaga (U.S. Patent No. 6,377,338). Applicant respectfully traverses these rejections for the reasons presented below.

In item 7 on page 4 of the Office Action, the Examiner indicated that dependent claims 13-20, 22, and 23 would be allowable if rewritten in independent form to overcome the § 112 rejections, including all of the limitations of the base claim (claim 10) and any intervening claims. Applicant has added the features of claim 23 to claim 10, cancelled claim 15, and rewritten claim 22 in independent form. Independent claim 30 includes the features of claim 10. Also, the remaining dependent claims (claims 11-14, 16-21, and 24-28) depend from claim 10.

Therefore, Applicant submits that claims 10-14, 16-22, 24-28, and 30 patentably distinguish over the prior art.

Accordingly, Applicant respectfully requests reconsideration and withdrawal of the rejections under § 102.

New Claims

Claims 31-38 are newly added with this response to alternatively define the present invention. The Examiner has indicated that dependent claim 13 contains allowable subject matter. Accordingly, new independent claim 31 corresponds to the claim combination 10/11/12/13. Claims 32-38 correspond to claims 14-20 and depend directly or indirectly from claim 31. Thus, Applicants respectfully request allowance of the new claims.

Conclusion

In accordance with the foregoing, it is respectfully submitted that all outstanding objections and rejections have been overcome and/or rendered moot, and further, that all pending claims patentably distinguish over the prior art. Thus, there being no further

Serial No. 10/079,519

Docket No. 1539.1019

outstanding rejections, the application is submitted to be in condition for allowance, which action is earnestly solicited.

If there are any formal matters remaining after this response, the Examiner is requested to telephone the undersigned to attend to these matters.

Finally, if there are any additional fees associated with filing of this Amendment, please charge the same to our Deposit Account No. 19-3935.

Respectfully submitted,

STAAS & HALSEY LLP

Date: June 6, 2003

By: C. Joan Gilsdorf
Christine Joan Gilsdorf
Registration No. 43,635

700 Eleventh Street, NW, Suite 500
Washington, D.C. 20001
(202) 434-1500

VERSION WITH MARKINGS TO SHOW CHANGES MADE**IN THE ABSTRACT**

Please **AMEND** the Abstract as follows:

A projection optical system transferring a mask image onto a substrate and correcting
[An embodiment of the present invention employs a combination of techniques for facilitating correction of] chromatic aberration. A [in the context of a projection optical system comprising one or more refractive optical members collectively comprising two or more fluoride substances. As one such technique, a] projection exposure system [comprises] includes at least two refractive optical members collectively [comprising] containing at least a first fluoride substance and a second fluoride substance, [wherein MX_1 is greater than MX_2 and] and satisfying the design condition $0.4 < \frac{MX_2}{MX_1} < 0.87$ [is satisfied], where MX_1 is the effective aperture of the [surface or] surfaces having the largest effective aperture from among the [surface or] surfaces of the refractive optical [member or] members [comprising] containing the first fluoride substance, [and] MX_2 is the effective aperture of the [surface or] surfaces having the largest effective aperture from among the [surface or] surfaces of the refractive optical [member or] members [comprising] containing the second fluoride substance, and MX_1 is greater than MX_2 .
[As another such technique, a] A projection exposure apparatus [comprises such a] includes the projection optical system and a light source [capable of] supplying radiation having a natural linewidth that is incident on a linewidth narrowing unit to provide radiation for exposure having a linewidth narrower than [a] the natural linewidth [thereof].

IN THE CLAIMS

Please **AMEND** the following claims:

10. (ONCE AMENDED) An exposure apparatus [capable of] transferring onto a substrate an image of a pattern on a mask, the apparatus comprising:

[a)] a light source [capable of supplying] emitting radiation [for exposure] having a natural linewidth;

a linewidth narrowing unit in the light source receiving the radiation having the natural linewidth and emitting radiation for exposure having a linewidth narrower than the natural linewidth;

[b)] an illumination optical system [arranged to receive at least some of] receiving the radiation from the light source and [guide at least some of] guiding the received radiation to the mask; and

[c)] a projection optical system [capable of] forming on the substrate an image of the pattern on the mask in correspondence to radiation received from the mask_i]; d) wherein] the projection optical system [comprises] comprising one or more refractive optical members collectively comprising at least two fluoride substances]; and

e) a linewidth of the radiation from the light source is narrower than a natural linewidth thereof], wherein

the at least two fluoride substances comprise a first fluoride substance and a second fluoride substance, and

each f -number FN_i of the one or more refractive optical members comprising the second fluoride substance satisfies a design condition of $0.8 < |FN_i|$.

16. (ONCE AMENDED) A projection exposure apparatus according to claim [15]14 wherein [a] the linewidth of the radiation from the light source is not more than half of [a] the natural linewidth thereof as measured on a full-width-at-half-maximum basis.

19. (ONCE AMENDED) A projection exposure apparatus according to claim 18 wherein [a] the linewidth of the radiation supplied by the light source is not more than 0.3 pm as measured on a full-width-at-half-maximum basis.

22. (ONCE AMENDED) An [A projection] exposure apparatus [according to claim 10 wherein] transferring onto a substrate an image of a pattern on a mask, the apparatus comprising:

a light source emitting radiation having a natural linewidth;

a linewidth narrowing unit in the light source receiving the radiation having the natural linewidth and emitting radiation for exposure having a linewidth narrower than the natural linewidth;

an illumination optical system receiving at least some of the radiation from the light source and guiding at least some of the received radiation to the mask; and

a projection optical system forming on the substrate an image of the pattern on the mask in correspondence to radiation received from the mask, wherein

the projection optical system comprises one or more refractive optical members collectively comprising at least two fluoride substances,

[a]) the at least two fluoride substances collectively comprise a first fluoride substance and a second fluoride substance [which are such that] with MX_1 [is] being greater than MX_2 [; and]

[b] the] a design condition $0.4 < \frac{MX_2}{MX_1} < 0.87$ is satisfied[;],

[c] where] MX_1 is the effective aperture of the surface or surfaces having the largest effective aperture among the surface or surfaces of the refractive optical member or members comprising the first fluoride substance[;], and

[d]) MX_2 is the effective aperture of the surface or surfaces having the largest effective aperture among the surface or surfaces of the refractive optical member or members comprising the second fluoride substance.

24. (ONCE AMENDED) A projection exposure apparatus according to claim 10 wherein [a] the linewidth of the radiation from the light source is not more than half of [a] the natural linewidth thereof as measured on a full-width-at-half-maximum basis.

27. (ONCE AMENDED) A projection exposure apparatus according to claim 10 wherein [a] the linewidth of the radiation supplied by the light source is not more than 0.3 μm as measured on a full-width-at-half-maximum basis.

30. (ONCE AMENDED) A projection exposure method for transferring onto a substrate an image of a pattern on a mask, the method comprising:

[a]) readying the mask for exposure;

[b)] readying the substrate for exposure; and
 [c)] using [a] the projection exposure apparatus according to claim 10 to form on the substrate [an] the image of the pattern on the mask.

31. (NEW) An exposure apparatus transferring onto a substrate an image of a pattern on a mask, the apparatus comprising:

- a light source emitting radiation having a natural linewidth;
- a linewidth narrowing unit in the light source receiving the radiation having the natural linewidth and emitting radiation for exposure having a linewidth narrower than the natural linewidth;
- an illumination optical system receiving at least some of the radiation from the light source and guiding at least some of the received radiation to the mask; and
- a projection optical system forming on the substrate an image of the pattern on the mask in correspondence to radiation received from the mask, wherein
 - the projection optical system comprises one or more refractive optical members collectively comprising at least two fluoride substances,
 - each of the refractive optical members within the projection optical system respectively comprises one or more fluoride substances,
 - the at least two fluoride substances collectively include calcium fluoride and barium fluoride,
 - the at least two fluoride substances collectively include a first fluoride substance and a second fluoride substance,
 - where MX_1 is the effective aperture of the surface or surfaces having the largest effective aperture among the surface or surfaces of the refractive optical member or members comprising the first fluoride substance,
 - MX_2 is the effective aperture of the surface or surfaces having the largest effective aperture among the surface or surfaces of the refractive optical member or members comprising the second fluoride substance,
 - MX_1 is greater than MX_2 , and
 - a design condition $0.4 < \frac{MX_2}{MX_1} < 0.87$ is satisfied.

32. (NEW) A projection exposure apparatus according to claim 31 wherein the projection optical system further comprises:

- at least one positive lens component; and
- at least one negative lens component, wherein
- at least one of the positive lens component or components comprises the first fluoride substance, and
- at least one of the negative lens component or components comprises the second fluoride substance.

33. (NEW) A projection exposure apparatus according to claim 32 wherein:

- the at least two fluoride substances collectively include a first fluoride substance and a second fluoride substance; and
- the f -number or the respective f -numbers of the refractive optical member or members comprising the second fluoride substance satisfies or satisfy the design condition $0.8 < |FN_i|$, where FN_i represents each such f -number.

34. (NEW) A projection exposure apparatus according to claim 33 wherein the linewidth of the radiation from the light source is not more than half of the natural linewidth thereof as measured on a full-width-at-half-maximum basis.

35. (NEW) A projection exposure apparatus according to claim 34 wherein the light source comprises an F_2 laser.

36. (NEW) A projection exposure apparatus according to claim 35 wherein the light source comprises:

- an oscillator generating radiation having a linewidth narrower than a natural linewidth thereof; and
- an amplifier capable of amplifying the output of the radiation generated by the oscillator.

37. (NEW) A projection exposure apparatus according to claim 36 wherein the linewidth of the radiation supplied by the light source is not more than 0.3 pm as measured on a full-width-at-half-maximum basis.

38. (NEW) A projection exposure apparatus according to claim 37 wherein the at least two fluoride substances collectively include two species selected from among the group consisting of calcium fluoride, barium fluoride, lithium fluoride, magnesium fluoride, strontium fluoride, lithium calcium aluminum fluoride, and lithium strontium aluminum fluoride.